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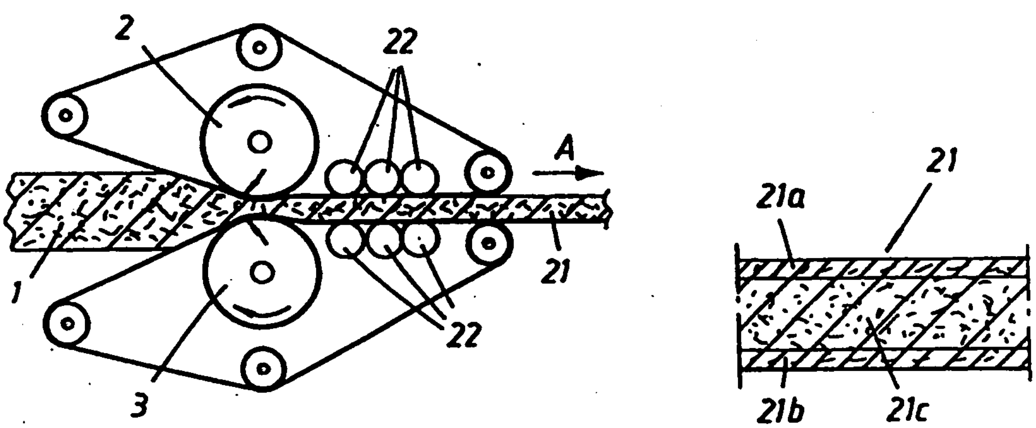
(54) Title: A METHOD OF PRODUCING LIGNOCELLULOSIC BOARDS



(57) Abstract

A method of the production of boards of a lignocellulosic fibrous material wherein a material is broken up into particles and/or fibers that are dried, glued and formed to a mat and pressed to a finished board so that steam is introduced to the mat. According to the present invention, the steam is introduced in a limited amount in a first injection step. This amount is adjusted so that the steam only penetrates into, heats and cures the surface layer of the mat. Thus, a board having a surface layer with a higher density than a middle layer is obtained so that the subsequent calibration compression provides a greater thickness that permits the middle layer to expand while the density of the surface layers is maintained.

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A Method of Producing Lignocellulosic Boards

The present invention relates to a method of producing lignocellulosic boards according to the preamble of claim 1.

Methods of producing boards of lignocellulosic material are well known and have significant practical applications. The manufacturing includes the following main steps: breaking up of the raw material to particles having a suitable size and/or fibers, drying to a predetermined moisture ratio and gluing of the material before or after the drying, forming of the glued material into a mat which may be constructed of several layers, possibly cold pre-compressing, pre-heating, water spraying of surfaces etc. and heat compressing under pressure and heat in a stroke compressor or a continuous compressor until the board is finished.

During conventional heat pressing, the compressed material is heated mainly by using heat coils from adjacent heating plates or the steel bands. These have a temperature of 150-200° Celsius depending on the type of product that is being compressed, the type of glue used, desired capacity etc. In this way, the moisture in the material is evaporated closest to the heat sources so that a dry layer is developed in this area and the steam front gradually moves towards the center of the board from each side as the compression continues. When the dry layer has been developed this means that the temperature in this layer is at least 100° Celsius which initiates the curing of conventional glues. When the steam front has reached the center, the temperature at the center has reached at least 100° Celsius and the boards even starts to cure at its center so that the compression can be stopped within a couple of seconds. This applies to situations when conventional urea formalaldehyde glue (UF) and similar glues are used such as melamine fortified (MUF) glue. When other glues, having a higher curing temperature, are used then a higher temperature and a greater steam pressure is required in the board before any curing can start. Methods have been developed for conventional hot pressing to control the density profile of the board in the direction of the thickness thereof. It is often desirable to achieve a high density at the surface layers for improved paintability, strength and similar properties and a suitably low density in the middle layers. The density should be as low as possible in the middle layers to maintain a low weight of the board and low cost but sufficiently high to achieve an acceptable transverse strength and other similar properties. When particle

boards are made, ground chips having a slightly higher moisture content are often used to achieve, among other things, a higher density of the surface layer of the board. Various methods of compression have been developed for making MDF (Medium Density Fiberboard) having a homogenous material structure so that the distance between the heat sources are controlled in a predetermined manner and the heat sources are gradually moved to the end position as the steam front is moved towards the middle of the board. For example, see SE patent 469,270 regarding continuous compression and SE patent application 93 00772-2 regarding a one step stroke compressor. The methods that have been developed for MDF are now also used, at least partially, for other board types.

To achieve the desired density, a compressor must apply a high surface pressure at a high temperature. This is not a problem for non-continuous compression in a so called stroke compressor but such compressors have other drawbacks such as worse thickness tolerances etc. When continuous compressors are used, the requirement for high surface pressures and high temperatures at the same time have led to expensive high precision solutions with regard to the roller felt between the steel band and the heating plate positioned below. The method of providing heat to the board via heat coils makes the heating relatively time consuming which results in long compression lengths (large compression surfaces). In addition, it is not practically possible to make the heating plates of continuous compressors sufficiently flexible and the density profile cannot be designed with the same latitude as with stroke compressors.

Today's continuous compressors are also limited with regards to temperature (due to the lubricating oil in the roller felt), which means that not all types of boards can be compressed.

Another method for board manufacturing is based on the fact that steam is introduced between the heating plates of a stroke compressor have also reached a limited success. Because the material is heated very quickly when the steam is introduced, the time required for heating can be radically reduced. Additionally, the resistance of the material to compression is very much decreased when steam has been introduced. This is a positive effect and means that the compressor could be made to provide less compression forces and be substantially shorter (less compression surface). To obtain the desired density profile of a board made according to this method, it has been necessary to use conventional compression techniques with high surface pressure

and heat conduction from conventional heating plates in the beginning of the compression cycle so that a surface layer having a high density is obtained after a long heating period. Only after this, has it been possible to blow steam into the middle portion of the board. Thus, a problem has been created because the it is necessary to blow the steam through the recently formed surface layer which has a high density. Also, the compression time required has been substantially increased within the period due to high pressure and heat conduction requirements. All this leads to a substantially lower capacity, or in the alternative greater compression surface, of a steam compressor and requires greater compression forces compared to the forces required if an even density was desired.

A soft surface layer having a lower strength, unacceptable paintability etc. are created by using all of the above mentioned manufacturing methods which means that this layer must be removed by grinding. Therefore, a material loss of 5-15% is obtained depending on the type of board, thickness etc.

Even for the manufacturing of boards using a continuous process heating by introducing steam has been known for a long time. See for example EP 383 572, US 2 480 851, GB 999 696, DE 2 058 820, De 3 640 682, DE 4 009 883 and AU 57390/86.

The steam can be injected into the material mat by using a steam box but this has certain drawbacks. To eliminate these drawbacks, an apparatus having perforated compression rolls have been developed which serves as a steam introduction member. Such an apparatus is described in SE 502 810.

SE 502,272 describes a method that uses the advantages of steam heating for achieve the desired density profiles of the finished board. The compression is performed in two steps wherein the mat in the first step is compressed to a moderate density having a substantially even density profile across the thickness thereof. In the second step, the mat is compressed to a higher density where the density profile is heterogeneous so that the surface layer has a higher density than the middle portion of the board. Between both of the steps the board is either fully cured or partially cured.

An object of the present invention is to remove the drawbacks that are associated with the prior art technology for manufacturing fibrous boards having a desired density profile and to take advantage of steam heating the fiber mat.

According to the present invention, this has been achieved through a method described in the preamble of claim 1 and the steps included in the body of the claim.

By introducing the steam in this way, the fiber mat is provided with a heterogenous structure wherein the surface layer is made soft and cured by introducing steam while the middle layers are substantially un-affected. Thus, the conditions have been created so that the subsequent calibration compression makes a board having a certain density profile by permitting this to occur at a greater thickness compared to what is accomplished at pre-compression so that the un-affected middle layer is permitted to expand under the surface layer that substantially maintains its density. The density of the middle layer is thus lower than the density of the surface layer. As mentioned in the introduction, it is in many situations desirable to have a surface layer having a higher density than the rest of the board and the method of the present invention provides an uncomplicated and inexpensive solution to achieve this where the drawbacks associated with the prior art methods to produce boards with such a density are avoided.

The mat should be pre-compressed at the time of or immediately before the steam is injected.

The method is particularly adapted to continuous production of boards wherein the steam is preferably introduced at the roller or at the rollers that are used for the pre-compression.

The thickness of the surface layer, having an increased density, can be brought about by regulating the amount of steam introduced so that the characteristics of the board with regard to, for example, bending strength and treatability can thus be adapted to the different applications.

The above mentioned and other preferred embodiments of the method of the present invention are described in the subsequent dependent claims.

A preferred embodiment of the present invention is explained in detail in the detailed description below and the preferred embodiment is shown in the drawings below wherein

fig. 1 is a schematic cross sectional view along the length of the mat and board at the time of compression,

fig. 2 is an enlarged cross sectional view through a board produced according to the present invention,

fig. 3 is a diagram illustrating the density profile of the board shown in fig.2,

fig. 4 is a schematic cross sectional view of a roller through which the steam is introduced,

fig. 5 is a cross sectional view of a portion of the roller of fig. 3,

fig. 6 is an axial cross sectional view of the roller of fig. 5, and

fig. 7 is a schematic cross sectional view illustrating the different treatment steps according to a preferred embodiment of the present invention.

Fig. 1 shows how a fiber mat 1 is conveyed in the direction of the arrow A and is compressed to a board 21. The mat is pre-compressed by a pair of rollers 2, 3 to a density that is close to the desired surface density. Steam is introduced through the rollers 2, 3 in a way that is explained in more detail below. The amount of steam that is introduced through the rollers 2, 3 is carefully adjusted so that the steam penetrates and only heats the surface layer of the mat. The thickness of this surface layer is proportional to the added amount of steam and can therefore be regulated by the amount of steam.

The surface layers are softened and cured by the heating of the steam introduced. The layer disposed in the middle of the mat, to which the no steam has penetrated, is unaffected.

After the mat has passed through the pair of rollers 2, 3 the mat goes in to a calibration zone where the mat is calibrated to a desired finished thickness. This thickness is greater than the thickness of the board when it was passed through the rollers 2, 3 so that the unaffected middle layer is expanded. During the passage in this zone, heat is introduced to such an extent that the middle layer is cured. The roller compressors 22 can be a different apparatus, for example, a conventional roller felt or a hydraulic felt. The result is that the finished board obtains a surface layer having a higher density than the middle layers. During the compression step between the pair of rollers 22, heat is introduced and the board is compressed while the heat is added until the middle layer is cured to obtain such a strength that it can withstand the existing expansion force.

Fig. 2 shows how the finished board 21 looks in a cross sectional view. Both the surface layers 21a and 21b have a density of about 800 kilogram/cubic meter while the density of the intermediate layers is about 600 kilogram/cubic meter. This is illustrated in the diagram of fig. 3.

Both or either of the rollers 2, 3 can be designed as is described in SE 502,810 and as is illustrated in figs. 4, 5, and 6.

The compression and injection roller 2 that is shown in fig. 5 is constructed with a perforated casing surface 6 for delivering steam to the mat 1. An axial channel system 7 is disposed inside the casing surface 6 around the roller 2. The channel system 7 is adapted to distribute the steam over the roller 2 and thus along the width of the mat 1. An adjustable sliding shoe (fig. 6) is arranged to sealing engage an end of the roller 2 to introduce steam into the channel system 7. The introduction of steam is thus performed to a limited section (fig. 4) of the roller 2 where the mat 1 is compressed. The limited sector 9 is surrounded at both sides, as seen in the periphery, by sealing zones 10 where the roller 2 is in contact with the mat 1. The channel system 7 can be closed at the opposite end of the roller 2. In the alternative, a sliding shoe 8 can be disposed at each of the ends.

The sliding shoe 8 is held in place by an adjustable stand so that the sliding shoe is adjustable along the direction of the periphery. In the way, the position of the injection sector 9 can be varied. The sliding shoe 8 is preferably includes a replaceable wear part 14 made of a low friction material that bears against a treated surface on the end of the roller 2. Thus, the sliding shoe 8 is held and pushed against the end of the roller 2 by, for example, springs, compressed air or hydraulically, so that any leakage in the sealing surface is minimized.

The sliding shoe 8 can be constructed with one or more channels 11, 12, 13 that can have different surface areas. Even replaceable wear parts 14 having different openings defined therein may be used such as a sliding plate having an opening that can be varied. Thus, the size of the injection sector 9 can be varied. What is more, different flows and pressures can be maintained in different parts of the injection sector 9. The channels of the sliding shoe 8 can also be used for cleaning and suction.

Fig. 6 schematically shows the contact surface of the sliding shoe 8 against the end of the roller 2. In this way, the sliding shoe 8 is equipped with injection channels 11 for steam, cleaning channel 12 and suction channel 13.

The perforated casing surface 6 on the roller 2 can be a stamped or drilled sheet metal having the shape of rings that have been heat shrunk onto the roller. Axial support moldings 15 for the sheet metal can be shaped into the casing sheet metal 16 on the roller by milling or casting or the sheet metal may be constructed as separate

moldings that are attached to recesses in the casing sheet metal 16. These moldings can at the same time limit the channel system 7 disposed inside the casing surface 6.

The openings of the channel system 7 at the end of the roller that have not been covered by the sliding shoe 8 can be sealed by pressing an adjustable sliding ring made of a low friction material against the end.

Fig. 7 shows a method according to the present invention including the different treatment steps that preferably precedes and follows the actual compression. The material mat 1 is brought to a predetermined temperature, moisture content and density.

The finished compressed board 21 is passed through an after conditioning zone 20. Furthermore, gases are collected in this zone, for example, formalaldehyde that is emitted from the compressed board. The board is also permitted to cool down in the conditioning zone because the high temperature of the board generated from the compression makes it plastic to a certain extent which makes it difficult to handle.

The above described preferred embodiments of the method of the present invention have been described in connection with the production of a board having a surface layer with an increased density on both sides. It is to be understood by a person of ordinary skill in the art that the steam, in the alternative, can be introduced on only one side of the mat to produce a board having an increased density on that side. Likewise, it is to be understood that the amount of steam can be regulated so that different amounts of steam are introduced on both sides of the mat so that a board having surface layers of different thicknesses with increased density are obtained.

PATENT CLAIMS

1. A method of the production of boards of a lignocellulosic fibrous material wherein a material is broken up into particles and/or fibers that are dried, glued and formed to a mat and pressed to a finished board so that steam is introduced to the mat characterized therein that, in a first steam injection step, a limited amount of the steam is introduced that is adjusted so that the steam penetrates into, heats and cures only the surface layer of the mat.

2. The method according to claim 1 wherein the mat is pre-compressed and that the limited amount of steam is introduced during or immediately after the pre-compression.

3. The method according to claim 1 wherein the method is conducted in a continuous process and at least one of the compression rollers is used for this pre-compression.

4. The method according to claim 3 wherein said limited amount of steam is introduced through at least one of the compression rollers.

5. The method according to any of claims 1 - 4 wherein said steam heated surface layer of the mat is calibration compressed to a desired board thickness so that said surface layer is provided with a higher density than the middle layer.

6. The method according to claim 5 wherein said middle layer is permitted to expand.

7. The method according to claim 6 wherein said calibration process is conducted at a greater thickness than the thickness that is obtained in the pre-compression to enable said expansion of the middle layer.

8. The method according to any of claims 5 - 7 wherein the amount of steam introduced is regulated depending on the desired of thickness of said layer having a higher density.

9. The method according to any of the claims 5 - 8 wherein said calibration compression is performed while heat is added.

10. The method according to claim 9 wherein the heat is added during the calibration compression and continuous until the middle layer is cured.

11. The method according to any of claims 2 - 10 wherein the mat is pre-conditioned prior to said pre-compression.

12. The method according to any of claims 1-11 wherein the finished compressed board is after-conditioned to change the moisture content of the board and gases emitted from the board are separated.

13. The method according to claim 12 wherein the board is cooled at said after-conditioning.

Fig. 1

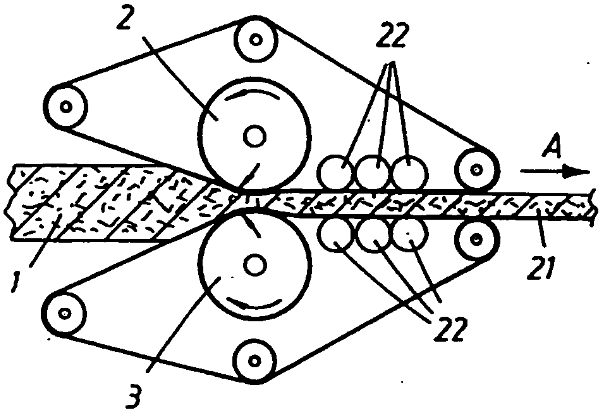


Fig. 2

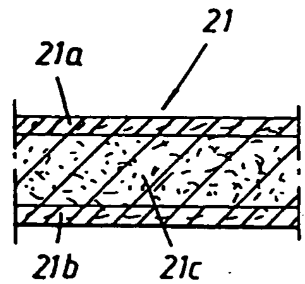


Fig. 3

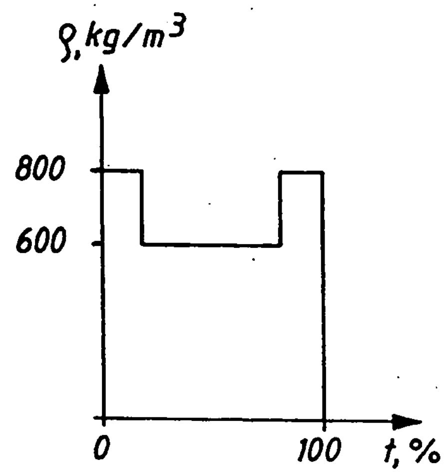


Fig. 4

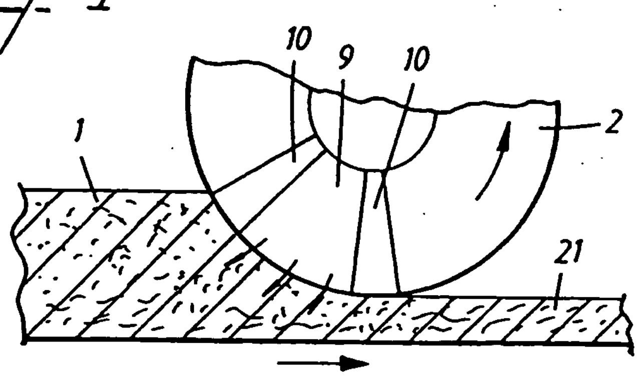


Fig.5

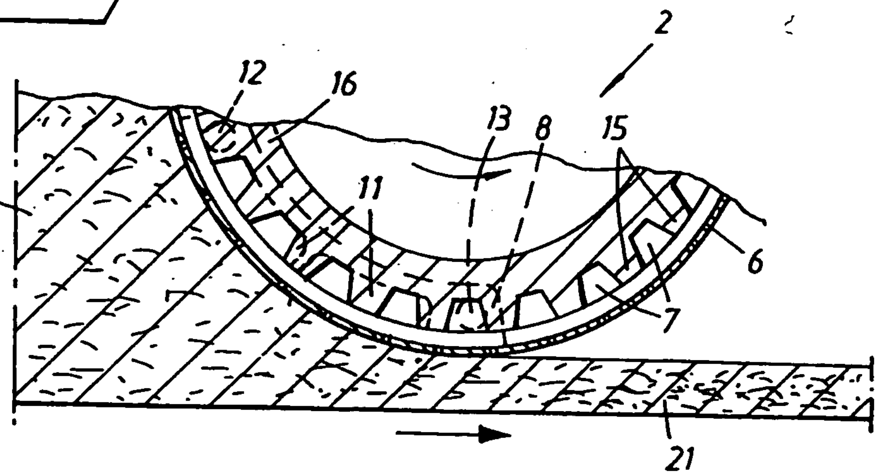


Fig.6

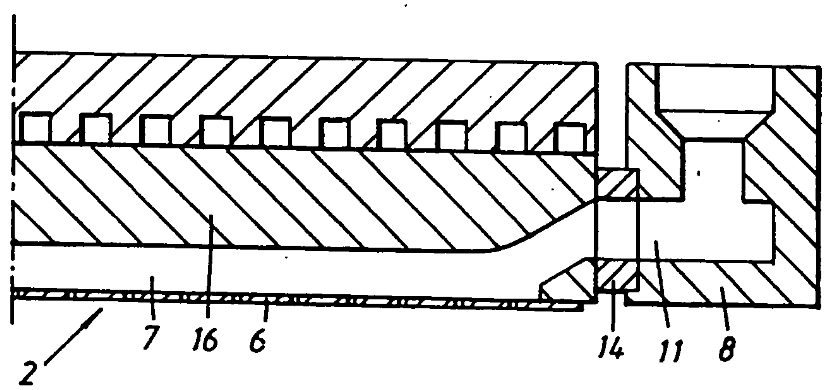
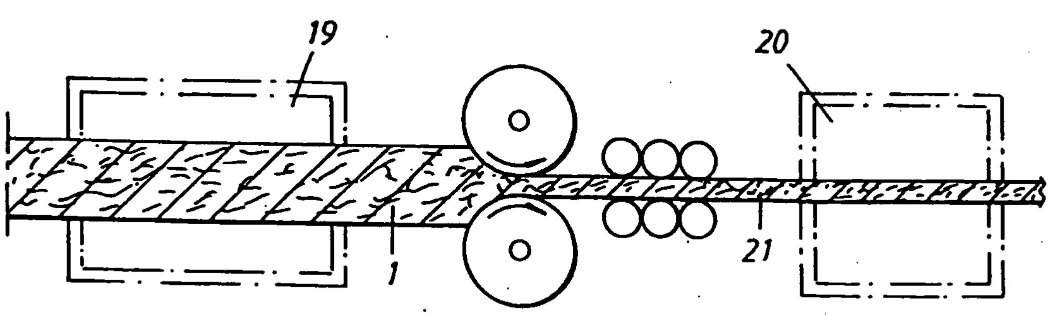


Fig.7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/00975

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B27N 3/18
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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B27N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4684489 A (KARL WALTER), 4 August 1987 (04.08.87) --	1
A	US 4517147 A (MICHAEL N. TAYLOR ET AL), 14 May 1985 (14.05.85) --	1
A	US 4393019 A (ROBERT L. GEIMER), 12 July 1983 (12.07.83) -- --------	1

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Date of the actual completion of the international search	Date of mailing of the international search report
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Information on patent family members

01/10/96

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4684489	04/08/87	AU-B- 573720	16/06/88
		AU-A- 5739086	20/11/86
		CA-A- 1255470	13/06/89
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